982

INFORMATION

FOR

AIR SERVICE MECHANICS

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The following publication, entitled "Information for Air Service Mechanics," is published for the information and guidance of all concerned.

[062.1, A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

PEYTON C. MARCH,
General, Chief of Staff.

OFFICIAL:
P. C. HARRIS,
The Adjutant General.

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CHAPTER VII.

CHECK MEASUREMENTS OF ALIGNMENT.

AIRPLANE SPECIFICATIONS.

When the airplane is turned over to the rigger for alignment, he is given a sheet or blue print which contains the specifications for that airplane. It shows him the dihedral angle and angle of incidence for that particular machine, the correct stagger measurement, etc. It is the rigger's duty to so assemble and align the parts of the airplane that they will conform exactly to these specifications. It is no part of his work to change these specifications and if the airplane does not fly correctly and the rigger finds that his work has been done in accordance with them, he simply reports the matter to the engineer officer for his further instructions.

SAMPLE SPECIFICATIONS.

Here are specifications for these modern airplanes:

Curtiss JN 4B military tractor.
Wing curve Eiffel No. 36.
Chord, $59\frac{1}{2}$ inches.
Gap $62\frac{3}{16}$ inches.
Stagger, $12\frac{5}{16}$ inches.
Dihedral, 1°.
Angle of incidence, 2°.

Bristol fighter.

Front beam, 37 feet 6 inches.
Rear beam, 39 feet 3 inches.
Dihedral, $9\frac{1}{2}$ inches.
Center section, 4 feet 3 inches.
Stagger, $4\frac{7}{8}$ inches.

De Haviland 4 battleplane.

Front beam, 40 feet 6 inches.
Center section, 2 feet 5 inches.
Dihedral, 3°.
Stagger, 12 inches.
Angle of incidence, 3°.

HOW TO MAKE CHECK MEASUREMENTS.

After aligning the airplane, the rigger makes the following check measurements of alignment, noting the figures down on paper. In case a mistake in alignment is discovered, do not attempt to correct it until all these measurements have been completed. It will frequently be found that one error in alignment or one defective part of the airplane will throw out two or more of these check measurements. By making all of them at one time and then comparing the resulting figures, the error in alignment of the defective part can be readily located.

ORDER OF CHECK MEASUREMENTS.

1. Check landing gear.

(*a*) Check diagonal measurements on front and rear struts.

(*b*) Place spirit level on axle.

(*c*) Center point of axle in line with plumb lines dropped from tail post and center point of front horizontal compression strut.

2. Level engine bed with spirit level, or with protractor and level if engine rails are set at angle.

3. Check center section.

(*a*) Make diagonal measurements on front struts equal.

(*b*) Make diagonal measurements from top front strut bolt to lower rear bolt on each side equal.

4. Check dihedral angle.

(*a*) Diagonal measurements from center point of center section panel to fixed point opposite intermediate front strut on lower panel each side equal.

(*b*) Diagonal measurements from center point of center section panel to fixed points opposite outer front struts on lower panel each wing equal.

(*c*) Diagonal measurements from top of intermediate front strut to butt of lower panel each wing and from top of outer front strut on each wing, measuring fixed distances out from butts of wing panels to establish these points, should be, respectively, equal. This proves the alignment of corresponding bays.

5. Check the stagger, using three plumb lines dropped over leading edge of upper panel on each wing, placed as follows:

(*a*) Next the fuselage.

(*b*) Opposite intermediate strut.

(*c*) Opposite outer strut. All six measurements to be the specified stagger given in blue print.

6. Check the droop. Do this by sight, as outlined. In case specifications give correct angle of incidence for each wing section, check these angles as outlined under 9. Establish fixed points opposite

strut fittings on trailing edge of each panel, measuring out equal distances on each panel from the butt of the wing. Take diagonal measurements from top fitting of rear center section strut to these points, two measurements on each side. Measurement on drooped wing should be, say, one-fourth inch longer at inner strut and five-eighths inch longer at outer strut than corresponding measurements on the other wing, this difference depending upon the amount of droop put in.

7. Check the drift.

(*a*) Make diagonal measurements from center of propeller hub to fixed points on opposite outer from struts on upper and lower panels each wing. The measurements on one wing should respectively equal the corresponding measurements on the other wing.

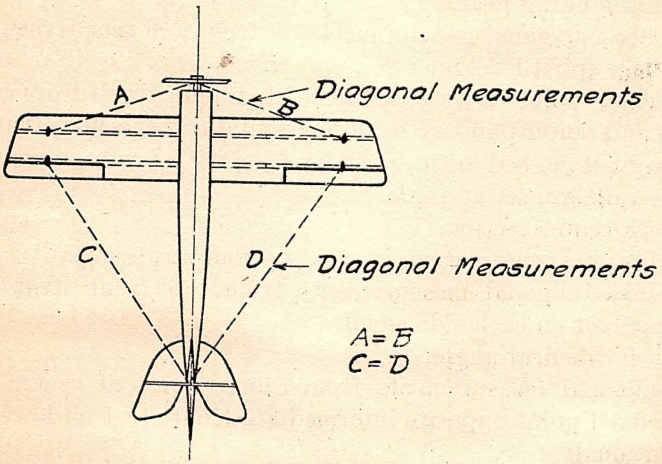

FIG. 56.—Checking measurements.

(*b*) Make diagonal measurements from the tail post to fixed points opposite outer rear struts on lower panels (trailing edge) and on upper panels. The measurements on one wing should, respectively, equal the corresponding measurements taken on the other wing. These measurements prove the correct alignment of the panels and the straightness of fuselage. Remember that of these measurements those on one wing will be slightly longer than those on the other if the wing is drooped.

8. Check the overhang and controlling surfaces.

(*a*) See that overhang of each upper panel is in true alignment with the entering edge of that panel.

(*b*) See that trailing edges of rudder, elevators, and ailerons are trued up straight, and that bracing wires are brought up to correct tension.

9. Check angle of incidence.

FIG. 57.—Checking drift.

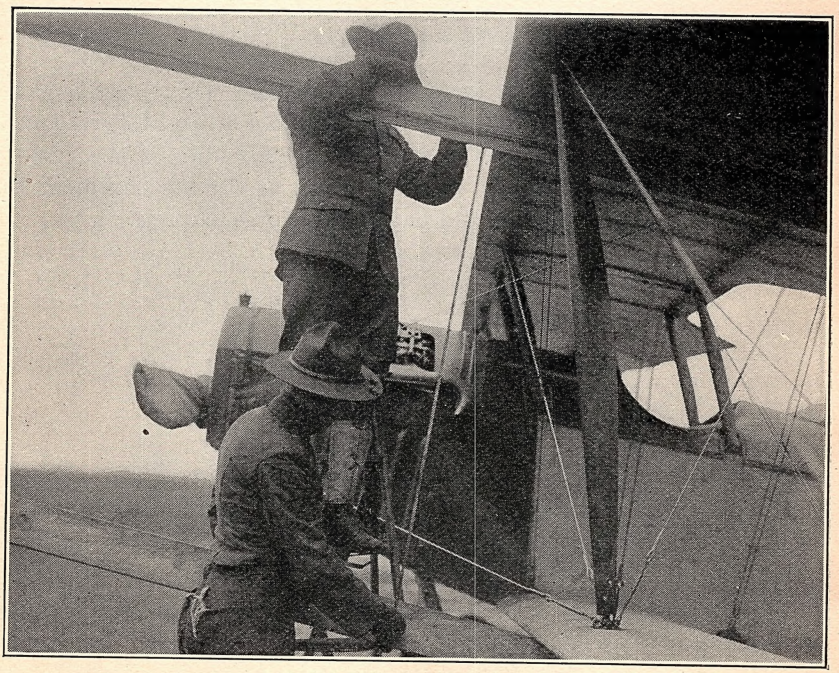

FIG. 58.—Measuring gap or perpendicular distance between wing chord.

At three points on each lower panel: (*a*) Near fuselage, (*b*) near intermediate strut, (*c*) near outer strut; measure vertical distance up from straightedge resting against panel's under surface at trailing edge and made horizontal with spirit level on it, to lowest point of panel's entering edge. This distance, considered as the rise in inches for the angle of incidence in the distance from leading to trailing edge of panel taken on the straightedge, should equal the rise in inches for the panel's angle of incidence of the specified number of degrees in the same distance. Use 0.0175 inch, the sine of 1 degree, to figure this.

10. Check the gap measurement. One measurement on each side, the perpendicular distance between the chords of the upper and lower panels represented here by two straightedges laid under these panels touching their leading and trailing edges, these measurements to be equal, and the specified gap measurement.

ESTABLISH FIXED POINTS FOR MAKING MEASUREMENTS.

In all cases, when establishing fixed points on panels from which to make check measurements, measure out equal distances from the butts of the panels and do not merely take points opposite the strut fittings. A fitting may be incorrectly placed on the panel and this will throw out all your measurements.

CHECKING RETREAT.

Where an airplane has backswept or retreating wings, the specification usually gives the distance in inches from a straight line touching the center point of the wings and perpendicular to the center line of the fuselage to the tip of each wing, as the measurement to be checked. This distance should be the same on each side.

CHAPTER VIII.

INSPECTION OF THE AIRPLANE AND INSTRUMENTS.

IMPORTANCE OF THOROUGH INSPECTION.

Outline for De Haviland battleplane and Liberty motor: A thorough, systematic inspection of the principal parts of the air-

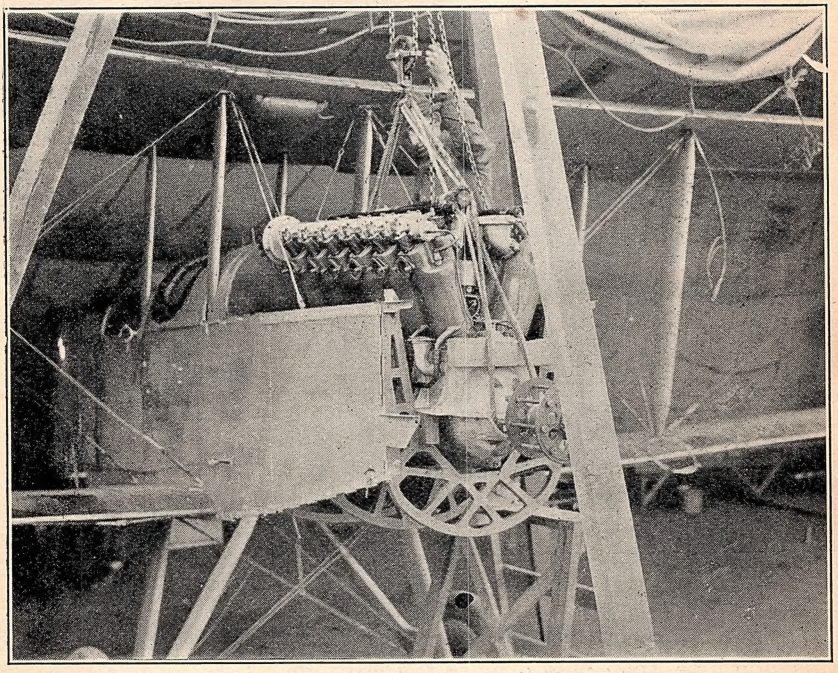

FIG. 59.—Liberty motor in De Haviland plane.

plane is absolutely necessary. Carefulness in this regard is one of the most important details which a good airplane mechanic must learn.

INSPECTION OF PROPELLER.

Starting at the front of the airplane examine propeller, hub nuts, hub flange, hub bolts. Everything here must be exactly right, nuts in

good condition, well cottered and locking wires firmly secured. Inspect propeller for bruises or checks, scratches, or laminations. Cracks may be distinguished from scratches by running a little ink into the crack. Tapping propeller with hand will often determine whether it is cracked. See that the propeller tracks. Make sure that propeller blades are not sprung or warped.

INSPECTION OF MOTOR.

Fill radiator, oil and gasoline tanks, examining connections of all these for possible leaks.

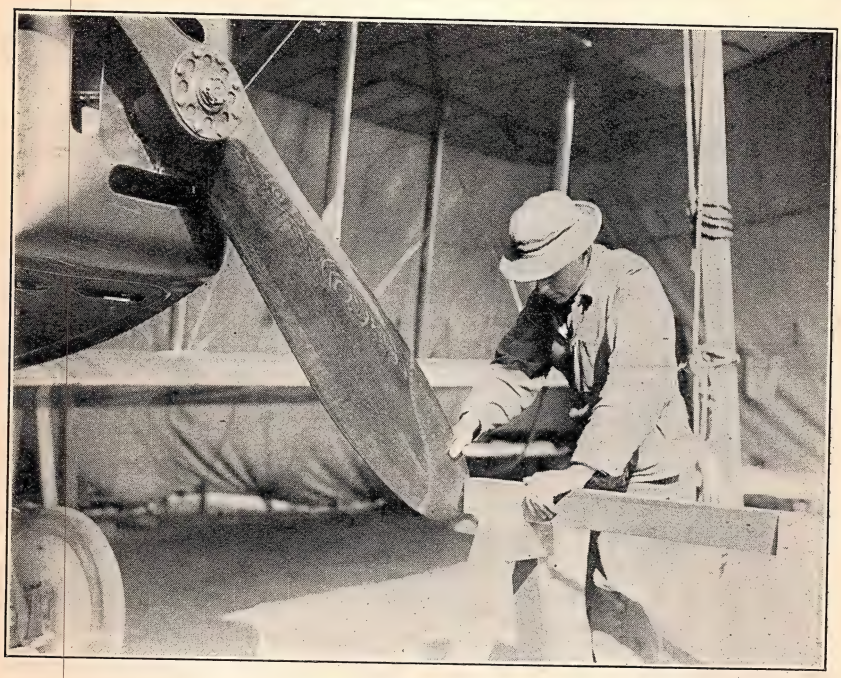

FIG. 60.—Inspection of propeller.

(*a*) Now inspect the motor. Start on the right side and complete this side first, then pass over to the left side. Look over all sparks for broken porcelain, oil, carbon and proper clearance, and at the same time see that the spark plug leads are free from broken insulations and that the connections to the plugs are tight. With the Curtiss motor, make sure that the leads from magneto to the spark plugs are placed so as not to interfere with rocker arm of the mechanism in any way. Special care should be exercised in getting a good contact for the ground wire.

(*b*) Now remove distributor and examine inside surface, particularly the contact segments and the path of the rotor brush. This surface should be clean, smooth, and free from scratches.

(*c*) Check breaker gaps with thickness gauge; they should be from 0.010 to 0.013 inches apart. Examine condition of points. Look at the rubber buffers against which the breaker arm spring bears. If they are in poor condition, the whole breaker arm assembly should be replaced. Examine breaker arm spring. Examine resistance unit and see that coils are all separated. Examine face of cam for signs of excessive wear. Examine all leads between generator, battery, switch, distributors for broken insulation and loose connections. Check valve clearance (intake, 0.013 to 0.016 inches; exhaust, 0.019 to 0.021 inches).

(*d*) Check up the carburetor. Remove the air scoops, disconnecting the overflow pipe from the scoops and testing same to see if clogged up. Remove jets and check sizes (145–155), clean if necessary. Examine each carburetor individually and see that the linkage between the carburetors is tight and in good condition. Check the altitude and adjustment the same way. Carefully examine the intake manifold for possible leaks. Check carburetor float adjustment. See that float is air-tight. Open valve and flush all gasoline lines to see that they are not clogged.

(*e*) Examine engine bed bolts to make sure they are tight and well cottered. Examine carburetor leads for leaks and loose couplings. See that all connections to oil and water pumps, also water connections to cylinders, are tight and in good shape.

INSPECTION OF ALIGNMENT.

Take position in front of airplane where the front and rear diagonal bracing wires, as you sight across them, form one X to the eyes. They should do this if the landing gear is properly aligned. Now lift your head and sight first one wing section and then the other, seeing that the leading and trailing edges of each section are perfectly parallel with the exception of the allowance you must necessarily make for any droop put into one wing.

As you proceed from left wing to right around the airplane working from the front to the rear, sight along the leading and trailing edges of each panel to make sure they are straight and free from bows. Sight the wing struts from a position at tip of each wing to see that they are in correct alignment, and the center section struts from a position in front of airplane to see that they are in fore and aft alignment. At least once a week make all check measurements of alignment as outlined in another chapter.

INSPECTION OF WING PANELS.

Now, starting at the front of the airplane, first inspect the landing gear making sure that diagonal bracing wires are taut and at equal tension, that turnbuckles are safety wired, that struts are not cracked or splintered, that spreader board is in good shape, that shock absorbers are firmly wound and securely fastened, that wheels are well greased, and that nuts are well brought up and cottered.

INSPECTION OF LEFT WING.

Next examine front wing hinges fastening on left wing and make sure the bolt and nut are well secured. Then taking the landing, flying, and stagger wires, make sure that all turnbuckles are safetied, that cotter pins are cut the right length and turned down so as to actually secure the clevis pins and nuts in which they are placed, that fittings are not bent or cracked, that landing and flying wires are at correct tension, pulling apart where they cross only about five-eighths of an inch when airplane is correctly lined up, and that these wires are taped where they cross. Landing wires only should be taped. Especially examine the drift wires and the eyebolts from which they run. All wires must be tight enough so that they will not vibrate when motor is running on ground.

In the Curtiss airplane the wing hinges are secured with hinge pins, and these must be both cottered and safety-wired. Inspect these pins on each panel, both from the front and the back. Remember there are eight of them to be looked over and that cotter pins must be put in and split, so as to hold the hinge pin. Safety wiring must be carefully and neatly done.

A very important point is to watch the wing-hinge fittings after a flight, for cracks either on the fuselage or on the butt of the wing panel. Such cracks are small and can be detected only by close examination.

See that wing struts are in good condition, not scratched, checked, or bowed. Make sure that all nuts are well cottered, that wing skid on underside of panel is O. K., and that there are no holes in fabric on either side. Roughened or torn fabric causes more resistance, and tears must be repaired at once.

Now come around behind the wing and examine the aileron, noting especially the fastening of aileron control wire to control post and inspecting the wire where it passes around pulleys for frays or broken strands. On Curtiss airplane inspect aileron bracing wires carefully, seeing that they are at good tension and well safetied, both on top and bottom of aileron. Inspect aileron hinge pins for cotter pins. Do not forget to inspect underside of upper panel closely.

INSPECTION OF TAIL UNIT.

Now, passing along fuselage and examining elevator and rudder control wires closely, go to tail and make sure that horizontal stabilizer is well secured at entering edge and that threaded fittings at trailing edge work easily and freely. On Curtiss airplane make sure that horizontal stabilizer is set down to place flat on top longerons and that nuts on U bolts are well brought up and cottered. Examine bracing wires on elevators, rudder, and fin for correct tension and safetying of turnbuckles.

Look over stabilizer, fin, and rudders to make sure that there are no holes in fabric and that hinge pins in elevators and rudder are well cottered. Pay particular attention to fastenings of control wires to control posts, and see that wires are not frayed here or where they pass around pulleys.

Now sight trailing edge of stabilizer to see that it is parallel with line of wing panels and then raise elevators to make sure that their trailing edges form one straight line. Test this by stretching string along these edges from one side to the other if necessary. Sight fin, which should appear to be in line with exact center line of fuselage looking from tail to front of airplane. See that tail post is well secured and not bent. Examine tail skid for worn shoe, broken skid, or worn shock-absorber cord.

Passing along right side of fuselage, examine elevators and rudder control wires. On the De Haviland, the connections of these control wires to the rudder bar, projecting through side of fuselage to the elevator control bar, should be carefully examined. The adjustments on these control wires are made with turnbuckles near the tail, and these must be carefully safetied. On the Curtiss airplane there are no control wire connections outside of the fuselage near the cockpit, but the turnbuckles and connections inside the fuselage must be carefully inspected.

INSPECTION OF RIGHT WING.

Passing to the trailing edge of right wing, look over all struts to make sure they are in good condition; watch fittings for breaks and cracks and see that all clevis pins and nuts are cottered. Don't forget under side of upper panel. Inspect right wing in reverse order from left, passing from trailing to leading edge around wing tip.

Now get up in cockpit and inspect top of airplane to make sure that compensating wire is not frayed or broken and that turnbuckle is safetied. See that control wires where they fasten to upper side of ailerons are in good condition and especially examine them where they pass around pulleys on leading edge. See that there are no holes in top panel. On Curtiss airplane, examine left and right cabane struts, front and rear, and overhang bracing wires.

NOTE FOR INSPECTING WIRES.

The principal defects in wires are: Strains, kinks, rust, broken strands or defective eyes. A strained wire usually shows one or more of the surface strands sunk deep into the core and this can be felt if the hand is passed along the wire. A wire that has been badly kinked and then straightened usually shows what is termed a "bird cage" at the point where it was kinked. Rust must be watched for and removed at once. A defective eye will first show the solder breaking away from the thimble and later breaking away on the whole splice. This should be remedied at the first little sign of trouble.

INSPECTION OF FUSELAGE AND CONTROLS.

From the seat in the cockpit, examine internal bracing of fuselage for defective wiring and wooden parts. The De Haviland has bracing rods of solid steel, and lock nuts on these should be well brought up. In the Curtiss airplane there are fuselage bracing wires of piano wire which should be brought up to good tension, holding fuselage in correct alignment. If any wires are loose, locate the trouble and correct it. See that turnbuckles are carefully safetied. See that rudder bar is firmly attached at base and that fittings, bolts, and control wires are in good condition. See that stick is not bent or loose in universal joint. Diagonal bracing wires between master struts are often liable to become loose.

In Curtiss airplane look over turnbuckles of rudder, elevator, and aileron control wires inside fuselage. See that aileron control wire is not kinked or crossed where it passes around drum of control wheel and that all pulleys are oiled and greased. Test aileron control by working the stick or wheel. The movement of the aileron should be easy, but without perceptible play.

The elevator control is considered the most important control, and should be carefully inspected before every flight. See that elevators come up exactly together and work freely without play in the wires.

INSPECTION OF INSTRUMENTS.

Check *throttle control* for tension. It should work tight enough so that it will not vibrate open or closed with the motor running. The *spark retard device* should be checked up. Switch and battery should be examined by throwing one or both switch levers in the "on" position when motor is still. Ammeter should show discharge. By "off" discharge should stop. Always leave *switch* in "off" position.

Try out the *hand-priming pump* by giving it a slow stroke, so you can tell if it is filling with gasoline. The *altimeter* or aneroid should be set at zero before every flight.

Examine *air speed indicator* for leaks in air line, capsularies leading to the pitot tube, or its couplings. Pitot tube should be aligned with the line of flight, its center line being in line with fuselage. Inaccuracy might make a decided difference in reading on the dial.

Clock should be set at the correct time before every flight.

The *hand pump* should be tested by pumping up the tank to about 3 pounds' pressure.

The *safety belt* should be closely inspected. The *seat* with its supports and bolts should be closely gone over.

The important rule in airplane inspection is to take nothing for granted, but to make sure by your own personal inspection and reason that everything is in safe and correct condition.

CHAPTER IX.

AIRPLANE INSPECTION CARD.

This card is filled out by student after airplane has been aligned and made ready for flight, to test his knowledge of the plane and give him an idea of the points to be covered.

Airplane No._____. Make_____. Model_____.
Motor No. _____. Make_____. Model_____.

NOTE.—Good condition means wires clean, well oiled, and unfrayed. Wooden parts clean, unsplintered, free from cracks or warps. Fill in all blanks. Answer "Good" or "Bad"; "Yes" or "No."

Motor: Switch off_____; ground wire on_____.
Propeller: Condition of blades_____.
Hub assembly (bolts, washers, cotters)_____.
Safety rings or wires O. K._____.
Tips secure_____.
Gasoline system:
Tank (tight to fuselage)_____.
Gasoline leads (connections tight)_____.
Pump (pressure correct)_____.
Carburetor:
Jets O. K._____.
Float free from leaks_____.
Needle valve seats O. K._____.
Bracing firm_____.
Manifold joints tight_____.
Oiling system:
Connections tight_____.
Pressure correct_____.
Water system:
Radiator full_____.
Connections to radiator and cylinders tight_____.
No air pockets in line_____.
Magnetos:
Numbers_____.
Mounting firm_____.
Breaker points clearance O. K._____. Spring, cam, and pin O. K._____.
Distributor:
Brushes and segments clean_____.
Wiring in good shape_____; (ground wire, switch H. T. D. wires).
Controls, rods, wires, and pulleys in good shape_____.

Valves:
Intake; clearance correct_____; no carbon_____; seat close _____.
Exhaust; clearance correct_____; no carbon_____; seat close _____.
Spark plugs:
Clean_____; no cracked porcelains_____.
Gap correct_____; terminals all right_____.
Engine bed:
Fastenings O. K_____.
Nuts well brought up and cottered_____.
Rocker arms oiled_____.
Spark plugs leads tight_____; insulation unbroken_____.
Fuselage and wings.
Landing gear:
Struts undamaged_____.
Sockets not bent or cracked_____.
Nuts tight and cottered_____; condition good, tension O. K.
Front diagonal bracing wires_____.
Rear diagonal bracing wires_____.
Axle straight_____.
Spreader board O. K_____.
Shock absorber rope unfrayed_____.
Shock absorber firmly wrapped_____.
Wheels greased_____; spoke tight_____.
Tires inflated_____; rubber uncut_____.
Hub cap on_____; bolt in, nut cottered_____.
Fuselage nose:
Radiator securely fastened_____.
Cowling unbroken and well fastened.
Left side_____; right side_____; top_____; bottom_____.
Center section:
Front struts undamaged_____.
Fittings uncracked_____; nuts cottered_____.
Rear struts undamaged_____.
Fittings uncracked_____; nuts cottered_____.
Center section panel untorn_____; tie wires safetied_____.
Turnbuckle safetied; condition good; tension correct.
Front cross wires_____.
Front brace wires_____.
Rear center drift wires_____.
Left wing:
Hinge pins wired correctly; fitting uncracked.
Front upper_____; lower_____.
Nuts cottered; fittings undamaged; wood uncracked.
Front strut, inner bay_____.
Front strut, outer bay_____.
Rear strut, inner bay_____.
Rear strut, outer bay_____
Turnbuckles safetied; condition good; tension correct.
Front landing wire, inner_____.
Front flying wire, inner_____.
Front landing wire, outer_____.

Front flying wire, outer_____.
Drift wire, upper_____.
Overhang flying wires, front_____.
Overhang flying wire, rear_____.
Rear landing wire, outer_____.
Rear flying wire, outer_____.
Rear landing wire, inner_____.
Rear flying wire, inner_____.
Stagger wires, inner bay_____.
Hinge pins wired correctly, fitting uncracked.
Rear upper_____; rear lower_____.
Wing skid, condition good_____; nut cottered_____.
Cabane struts, front_____; rear_____.
Overhang bracing wires, front_____; rear_____.
Ailerons:
Hinge fittings O. K., upper_____; lower_____.
Hinge pins cottered, upper_____; lower_____.
Bracing wires tensioned and turnbuckles safetied.
On top surface_____.
Bottom surface_____.
Aileron control wire.
Condition at pulley_____.
Connection safetied_____.
Connection at fuselage_____.
Compensating wire, condition_____; nut cottered_____; pulley_____.
Struts between ailerons, condition_____; connections_____.
Wing fabric torn or frayed_____. If so, where_____.
All clevis pins put in from top down and cottered_____.
Right wing:
Hinge pins wired correctly; fitting uncracked.
Rear upper_____; rear lower_____.
Nuts cottered; fittings undamaged; wood uncracked.
Rear strut, inner bay_____.
Rear strut, outer bay_____.
Front strut, outer bay_____.
Front strut, inner bay_____.
Turnbuckle safetied; condition good; tension correct.
Rear landing wire, inner_____.
Rear flying wire, inner_____.
Rear landing wire, outer_____.
Rear flying wire, outer_____.
Overhang flying wire, rear_____.
Overhand flying wire, front_____.
Front landing wire, outer_____.
Front flying wire, outer_____.
Front landing wire, inner_____.
Front flying wire, inner_____.
Drift wire, upper_____.
Drift wire, lower_____.
Stagger wires, outer bay_____.
Stagger wires, inner bay_____.

Hinge pins wires correctly; fitting uncracked.
Front upper_____; front lower_____.
Wing skid, condition good_____; nut cottered_____
Cabane struts. Front_____; rear_____
Overhang bracing wires. Front_____; rear_____
Ailerons, right wing:
Hinge fitting O. K., upper_____; lower_____
Hinge pins cottered, upper_____; lower_____
Bracing wires tensioned and turnbuckles safetied.
On top surface, upper_____; lower_____
Bottom surface, upper_____; lower_____
Aileron control wire, upper_____; lower_____
Condition at pulley, upper_____; lower_____
Connection safetied, upper_____; lower_____
Connection at fuselage, upper_____; lower_____
Compensating wire, condition_____; connections_____
Wing fabric torn or frayed_____; if so, where_____
All clevis pins put in from top down and cottered_____
Struts between ailerons, condition_____; connections_____
Tail unit:
Horizontal stabilizer—
Condition, U-bolts, left side_____; right side_____
Nuts cottered, left side_____; right side_____
Stabilizer braces bolts, left side_____; right side_____
Nuts cottered, left side_____; right side_____
Stabilizer aligned with wing panels_____
Elevators, left—
Top control wire, condition_____; nut cottered_____; tension_____
Bottom control wire, condition_____; nut cottered_____; tension_____
Top control horn, condition_____; nuts cottered_____;
Bottom control horn, condition_____; nuts cottered_____
Top brace wires safetied_____; tension correct_____
Bottom brace wires safetied_____; tension correct_____
Hinge pins in correctly_____; cottered_____
Rudder:
Hinge pins in correctly_____; cottered_____
Left rudder control wires, condition_____; nuts cottered_____
Right rudder control wires, condition_____; nuts cottered_____
Left brace wires tension correct_____; safetied_____
Right brace wires tension correct_____; safetied_____
Rudder in true alignment with fin_____
Fin:
Condition_____; nuts cottered_____
Fin bracing wires tension correct_____; safetied_____
Fin aligned correctly at right angles to stabilizer_____
Tail skid:
Condition_____; nut cottered_____; shoe worn_____
Shock absorber cord worn_____; fastened firmly_____
Elevator, right:
Top control wire, condition_____; nut cottered_____; tension_____

Bottom control wire, condition_____; nut cottered_____; tension_____
Top control horn, condition_____; nuts cottered_____
Bottom control horn, condition_____; nuts cottered_____
Top brace wires safetied_____; tension correct_____
Bottom brace wires safetied_____; tension correct_____
Hinge pins in correctly_____; cottered.

Controls and fuselage from pilot's seat:

Throttle, condition_____; no perceptible play_____
Aileron control wire—
Attached to drum securely_____
Turnbuckles safetied_____
Oiled and greased_____
No perceptible play_____
Elevator control wires, right, condition_____
Turnbuckles safetied_____
No perceptible play_____
Oiled and greased_____
Elevator control wires, left, condition_____
Turnbuckles safetied_____
No perceptible play_____
Oiled and greased_____
Rudder control wires, right, condition_____
Turnbuckles safetied_____
No perceptible play_____
Oiled and greased_____
Rudder control wires, left, condition_____
Turnbuckles safetied_____
No perceptible play_____
Oiled and greased_____
Control yoke and wheel, condition_____; fastenings secure_____
Safety belts securely attached_____; condition_____
Seats fastened securely_____; condition_____
Fire extinguisher installed_____
Alignment of rudder correct_____
Alignment of elevators correct_____; right_____; left_____
Alignment of ailerons correct_____; right_____; left_____
Wind shields all right_____; inspection cover fastened_____

Alignment of airplane:

A. Landing gear—
1. Level on axle correct_____
2. Center point of strut lines with plumb lines_____
3. Diagonal measurements equal. Front_____; rears_____
B. Engine bed level—Laterally_____; longitudinally_____
C. Center section—
1. Front diagonals equal_____
2. Side diagonals equal_____
D. Wing sections, dihedral angle—
1. Diagonal measurements equal; inner front_____; outer front_____
2. Corresponding bays check; inner bays_____; outer bays_____

E. Stagger, 3 measurements each wing, all equal—
   1. Left wing a_____; b_____; c_____
   2. Right wing a_____; b_____; c_____

F. Alignment of chord—
   Left wing correct_____
   Right wing correct_____

G. Droop, check by sight, skid fitting showing on drooped wing.
   Droop correct _____.

H. Drift. Diagonal measurements.
   1. From center propeller hub to wings, left _____, right _____.
   2. From tail post to wings, left _____, right _____.

I. Overhang. This should exactly align with upper panel.
   1. Left wing _____.
   2. Right wing _____.

J. Angle of incidence: Three measurements on each lower panel.
   1. Left wing, a _____ ; b _____ ; c _____.
   2. Right wing, a _____ ; b _____ ; c _____.

K. Gap measurement: One measurement on each wing section.
   1. Left wing _____.
   2. Right wing _____.

L. Backsweep or retreat: Check this from specifications, if any.
   1. Left wing _____.
   2. Right wing _____.

(Signed) Student _____

No. _____

Instructor _____

No. _____

Date _____

CHAPTER X.

COMMON RIGGING FAULTS AND REMEDY.

LOCATING FAULTS IN ALIGNMENT.

"There's a reason" for every trouble encountered by the aviation mechanic in his work. The fault is more likely to be in the rigger's work than in that of the airplane designer or manufacturer. Moreover, exact and accurate methods have been laid down for the assembly and alignment of the airplanes. By depending upon his rule and steel tape, the rigger can set out to definitely locate the trouble through mathematical check measurements and then correct it. The great point is to work systematically, and if perfect alignment is not secured at once, to start over and work out each step carefully. Sometimes after failing to get correct alignment the rigger will find that his measurements will never be right either because a strut fitting is incorrectly placed on the panel or because a center section strut is an eighth of an inch too long or too short. Either of these things will be discovered and remedied before the rigger commences the alignment, if he follows his instructions closely. Too often he disregards them. Mistakes cause costly delays, therefore the work must be done correctly the first time. Every rigger should be held individually responsible for the correct execution of his own work.

CAUSES OF A POOR LANDING.

1. The pilot may have difficulty in landing smoothly, because the elevator control wires are drawn up too tight, making the airplane hard to control. Remedy this by loosening lower elevator control wires.

2. The landing gear may be poorly aligned or the nuts holding the strut bolts on one side may be loose. This will cause an uneven stress on the landing gear struts and perhaps throw the machine to one side in landing. The airplane is also liable to swing around and nose over if one tire is flat, if the spokes in one wheel are loose or if

one wheel is ungreased, causing it to freeze on the axle. Then, too, one shock absorber may be pulled up tighter than the other. Make sure that all nuts are brought up evenly and securely. See that landing gear is aligned correctly. See that tires are pumped up to the same pressure, that wheels are greased, that spokes are tight, and that both shock absorbers are wound at about the same tension and their wrappings securely fastened.

WHEN AIRPLANE FLIES NOSE HEAVY.

If the airplane flies nose heavy:

1. Check the stagger as the center of lift will move back across the panel and the pull of gravity will overbalance it in front if there is too little stagger. Pull the upper panel forward.

2. Examine the horizontal stabilizer, for if the entering edge is not properly secured it may give the stabilizer an angle of incidence and consequently a lift which it is not designed to have.

3. See if the fuselage has been warped downward at the tail. This would cause the horizontal stabilizer to have an angle of incidence and a resulting lift which would bring the tail up and the nose down.

WHEN AIRPLANE FLIES TAIL HEAVY.

If the airplane flies tail heavy:

1. Check the stagger, as the center of lift will move forward across the panel and the pull of gravity will overbalance it toward the tail if there is too much stagger. Pull the upper panel back.

2. Examine the horizontal stabilizer, for if the trailing edge is not properly set down to place, it may give the stabilizer a negative angle of incidence, thus pushing the tail down.

3. See if the fuselage has been warped upward at the tail. This would cause a downward air pressure on the upper surface of the stabilizer, thus pushing the tail down.

ONE WING HIGH.

If the airplane flies one wing high:

1. Check the angle of incidence of each wing. One wing probably has more incidence than the other, either because the chord has not been properly aligned or because the flying wires have not been tensioned enough, allowing the alignment of the wing to change when in the air. Then, too, the surface of the panel may be warped or one wing may be set higher than the other. Both these faults should be watched when aligning the chord of wings.

2. The wing may have been drooped too little or too much. Check the droop.

3. If each panel is not set at the correct dihedral angle, or if the center section has not been trued up accurately, this would be apt to make the airlane fly one wing high.

PULLS TO RIGHT OR LEFT.

If the airplane pulls to the right or left:

1. Check the fin or vertical stabilizer, for it will act as a fixed rudder, throwing the airplane off its course to one side or the other if it is not exactly in line with the center line of the fuselage. It may either be warped or simply out of adjustment.

2. If the fin checks correctly, hang a plumb line from tailpost, one from center of front horizontal compression strut, and one from center line of fuselage about midway of its length, sighting them to see if fuselage is warped to one side or the other. This would throw the fin out of line and cause it to act as a fixed rudder.

3. If the struts on one wing section are not in streamline position, or if the panels are warped or for some other reason there is more drift on one wing section than on the other, this would have some effect in throwing the airplane off its course.

4. Measure the drift wires and see if one of them has been tensioned too much, in this way pulling one wing section ahead and out of alignment with the other. This would throw the airplane out of its course.

POOR CLIMB OR POOR SPEED.

If the airplane flies with decreased climb and speed:

1. Make sure that the wings are properly aligned, and that there is not too great a dihedral angle. In windy weather, with too much dihedral angle, the airplane will tend to stabilize itself with a continuous rocking motion from side to side. If the wings are not properly aligned, this will cut down the speed and climb.

2. Similarly, make sure that the panels are not distorted or warped, as this fault would cause the same result.

3. In every case, think for yourself and reason out the cause of the trouble carefully.

CHAPTER XI.

FIELDWORK, CARE, AND INSPECTION.

FIELD TROUBLE SHOOTING.

In order that the aviation mechanic may correct faults in alignment or motor troubles quickly, so as to keep the airplane to which he is assigned flying full time, he is given constant practice in trouble shooting. His work on the engine is reviewed, and, as the correct practice for each operation is contained in a separate pamphlet, the details will not be repeated here.

In correcting faults in alignment, actual problems such as he will encounter on the field are given him to work out successfully.

CARE AND INSPECTION OF MOTOR.

Clean off motor thoroughly, washing it down from the top with gasoline and a good brush, being careful not to leave oil or gasoline on spark-plug porcelains or insulation of spark-plug leads. Drain the radiator and clean it, flushing it with hot water and soda, if it has been used for a long period. This tends to remove dirt and any chemical deposits from the water and gives the radiator full cooling efficiency. Inspect radiator for leaks at this time. Fill radiator with clean water, resting funnel on edge of opening. Remove drain plug and drain off the oil from motor crank case. Motor should be refilled with clean oil after so many hours of running, as dirt, carbon, and particles of steel from the moving surfaces of the engine are apt to get into it and cause trouble. Refill with clean oil and examine oil leads for leaks.

Taking into consideration the clearance given the bearings and the kind of oil to be used, see that the oil pressure is correct. Increase oil pressure by screwing in the adjusting screw at filler pipe (on Curtiss engine) near front of motor. Decrease pressure by screwing out this screw.

Trace out ignition wiring leading from distributor head to spark plugs and be sure that wires are connected up to correspond with

the correct firing order of the motor given in the specifications. Examine wires at this time for broken insulation. Examine spark-plug gaskets which fit over spark plugs when they are inserted, to see that they are not bent and out of shape or broken. The internal gaskets can only be examined by taking the plug apart for cleaning, and this practice is not recommended.

SPARK PLUGS.

Clean the spark plugs, being careful not to break porcelains when removing plugs. Always use a spark plug wrench. Wash off the porcelain tip and electrodes with brush dipped in gasoline and be sure that plug is absolutely clean, with all dirt and oil wiped off its outside before it is replaced. Screw it in tightly, being sure to put on copper gasket and being careful not to crack the porcelain. Make sure that ignition is grounded, ground wires from breaker box to switch and to engine being securely fastened.

MAGNETO.

Inspect brushes in magneto, cleaning if necessary and if points are worn unevenly or are smooth and shiny, file them down to an even, dull surface with a fine file. Get their ends true and square. Clean collector ring and brush if necessary. Wipe off collector ring with a cloth dipped in a little gasoline.

CARBURETOR.

See that slow speed adjustment of carburetor is correct. Screw the adjusting screw on the carburetor all the way in, and after starting motor, screw it out until motor is running well on as large an allowance of air as possible. When adjusting screw is screwed out, more air is added to mixture.

AIR POCKETS IN GAS LINES

See that there are no air pockets in gas lines. These may form especially at turns or bends in gas lines. To remove them, disconnect gas line at tank and flush out line with full pressure. If air pockets were allowed to remain, they would cause the carburetor to operate badly.

WATER LINES.

Go over all water leads from radiator to pump, from pump to cylinders, and from cylinders to radiator, and make sure that all connections are tight, and that there are no leaks.

PROPELLER.

Before placing propeller, put oil on end of crankshaft if of tapering type. Attach propeller, putting on nuts, and safetying securely with locking rings and safety wire. Check alignment of propeller, placing blocks of wood under tip, marking spot where one end touches block when propeller is turned over, and seeing that the other tip touches the same spot within an eighth of an inch.

Check position of the propeller in relation to the breaker points in the magneto, seeing that these points separate at the proper point for the man cranking.

Examine propeller carefully for possible cracks, running a little ink into a crack if necessary to distinguish it from a scratch on the blade. Tapping propeller with hand will often help determine cracks. See that it is not chipped or sprung and be sure to keep it clean and free from moisture and oil. The propeller must be wiped off immediately after the airplane returns from a flight. Examine tips of propeller carefully to make sure that they are in perfect condition, not bent loose or cracked in any way.

VALVE CLEARANCES.

Be sure that switch is turned off; turn motor over carefully and check valve clearances with a thickness gauge. If these clearances are not correct the motor will not operate at full efficiency. Check these carefully against the clearances specified for that particular motor. After checking these clearances change them if they are correct and readjust or adjust them if they are incorrect, so as to secure practice in adjustment of valve clearances. Understand clearly how to use the thickness gauge.

PREPARING MOTOR FOR STARTING.

Fill gasoline tank and examine gasoline leads for leaks or loose joints. With switch off and throttle closed practice cranking, following correct practice in regard to position, swinging propeller and so on very closely. Examine operation of self-starter if installed on motor; make sure that starter pump is well lubricated and go over all air connections to pump and cylinders, making sure that they are tight and that there are no leaks. The operation of all switches and controls should be clearly understood before motor is started, and should be gone over and examined for adjustment and correct operation.

CRANKING.

Using signals "off" and "contact," be sure that pilot understands exactly how to cooperate with mechanic at the propeller. Start the

motor but do not speed it, then open throttle gradually as motor warms up. Make sure that blocks are placed in front of wheels and that airplane is tied at tail during this practice work.

For practice in locating troubles, gasoline is shut off and mechanic is required to locate the trouble; valve clearances are changed and mechanic is required to locate trouble and correct the wrong clearances; a spark plug is short circuited and mechanic is required to locate the difficulty and correct it. Many similar troubles can be prepared by the instructor, which will give the student ample experience in this line of work.

AIRPLANE TROUBLE SHOOTING.

In forced landings certain parts of the airplane are more apt to be broken than others, and the mechanic must know how to remove and replace these broken parts as quickly as possible.

REPLACING WING STRUT.

Working in sections, the crew will take off and replace a wing strut, a wing skid, and an aileron control horn. Loosen all landing, flying, and stagger wires on the wing section. With a Curtiss airplane the strut can be slipped out after the strut bolts have been removed. With a large, heavy airplane a beam can be pushed up under the upper panel, resting the strut fitting, and having another beam running across it horizontally on the ground and acting as a lever over a block under its end to lift up the upper panel sufficiently so that the strut may be removed. Be careful that the beam does not slip and puncture the fabric, and see that strut fitting and strut itself is not injured. Next realign the entire airplane after replacing strut.

BROKEN WING.

Wing skids are frequently broken in bad landings. Take out bolts and nuts; remove wing skid and replace with new one. See that nuts are well cottered.

REPLACING AILERON.

Disconnect aileron control wire, loosen safety wire on turnbuckles which adjust bracing wires. Take out nuts and bolts and remove control horn; replace with new one; true up trailing edge of aileron control wire and adjust ailerons correctly.

NEW CENTER SECTION STRUT.

The center section panel supports the wing sections which are hinged to it, and if it is seriously injured, the alignment of the airplane will be thrown out, and it will not fly correctly. Consequently

when a center section strut such as one of the rear center section struts is broken or injured so that it must be replaced, the greatest care must be taken in replacing it. All the landing, flying, and stagger wires on the inner bay of each wing section should be loosened and the front cross wires, the front bracing wires, and the rear counter drift wires of the center section should also be loosened. Now, remove the nuts and bolts in the rear center section strut; lift up the panel and slip out the strut. Replace with a new one; put in bolts and nuts, realign center section first, and then completely realign entire airplane.

If strut does not fit correctly or if extreme care is not exercised in replacing strut and aligning center section, the alignment of the entire airplane may be thrown out so that it will not fly true.

CHANGE IN DIHEDRAL.

Change dihedral angle one-half degree if so authorized by engineer officer, and realign airplane.

CHANGE IN STAGGER.

Change stagger measurement one-half inch if so ordered by engineer officer, and realign airplane.

CORRECTION OF RIGGING FAULTS.

1. Presuming that the pilot reports the airplane flying one wing high, locate the trouble as outlined in the previous chapter and correct it, realigning airplane.

2. Presuming that the airplane flies tail heavy, locate the trouble as outlined in the previous chapter and correct it, realigning the airplane.

3. Presuming that the airplane flies nose heavy, locate the trouble as outlined in the previous chapter and correct it, realigning the airplane.

4. Locate the cause of the trouble if the airplane is supposed to be rolling (1) in calm weather, (2) in windy weather, and correct it as suggested in previous chapter.

5. Take time enough to make the alignment carefully, and follow the instructions given for each operation. The point to remember is this: While the airplane may make a flight and return safely, even if some little point in its alignment has been neglected, it may also fail to return safely. But when it is correctly aligned in exact accordance with your instructions, no point being slighted, you can be absolutely sure that there will be no accident on account of any fault in rigging or alignment, and that no blame will be attached to the mechanic.

CHAPTER XII.

DISASSEMBLY AND STORING OF AIRPLANE.

ORDER OF DISASSEMBLY.

In disassembling an airplane the following order is observed:

1. Remove wires and locking rings on propeller hub, unscrew hub nut, remove propeller with puller and hang up.
2. Remove safety wires from turnbuckles.
3. Loosen landing, flying, and stagger wires.
4. Disconnect drift wires and coil up.
5. Disconnect compensating wire on upper panel and coil up.
6. Disconnect aileron control wire on each wing where it passes through into fuselage and coil up.
7. Remove safety wires from wing hinge pins and remove cotter pins.

DISASSEMBLY OF WING SECTIONS.

Disconnect inner landing and flying wires on right wing, having two men support the wing at the tip. Now put two men at butt of lower panel and have another man knock out hinge pins with a drift pin and hammer, first the top, and then the bottom. Replace hinge pins in fittings, and secure them there with a bit of wire.

Now lift off the wing section and set on ground, resting the leading edges of the panels on pads. Disconnect inner landing and flying wires on left wing, and remove the left wing section in the same way. Disconnect and coil up the compensating wire where it fastens to the top surface of each aileron. Disconnect and coil up the aileron control wire running to the under surface of the aileron. Remove the ailerons, replacing hinge pins in the wing fittings and securing them there with bits of soft wire.

Disconnect and coil up landing and flying wires on each wing section, securing the clevis pins in the turnbuckle forks with bits of soft wire. Disconnect these wires at the fittings so they will coil up on the under side of the panel, and do not unscrew any eyebolts from turnbuckles so that the threads will be exposed and injured.

Take out struts replacing nuts and bolts in the strut sockets on panel. Disconnect stagger wires and coil up. Lean panels upon solid support, tying them there so they will not by any chance blow over. Wire struts together through bolt holes and stand them on end.

When transporting an airplane from one place to another, the jolting over the roads will cause parts to work loose and become lost unless they are tightly fastened. One man's duty should be to see that every part is securely fastened before making a trip with an airplane.

PACKING FOR STORAGE.

If the airplane is to be packed and stored away, the following precautions must be taken. All bolts, nuts, and fittings should be cleaned off and then coated thoroughly with grease, so that they can not rust. All wires must be wiped off and then coated with oil. Wrap the coils of wire with strips of canvas, waterproof cloth, or paper. Attach an identification tag to every part bearing the Air Service number of the airplane.

The wing panels and air foils will be packed in padded racks so constructed that the panels can not come loose or fall down. The leading and trailing edges must be protected from any damage. The struts should be wired together in bundles through the bolt holes and then wrapped in cloth. The tires should be removed from the landing gear wheels and deflated, storing them where they will not be exposed to the influence of oil or moisture.

The landing gear in this case will be entirely disassembled, and all metal parts will be cleaned and oiled to protect them from rust. The fuselage will be securely blocked up on a firm foundation and its metal parts protected from rust with a coating of oil and grease. The cockpit and the fuselage will be covered over to keep off the dust, and the place of storage must be as clean and dry as possible.

The control horns should be removed from the ailerons, elevators, and rudder, the nuts and bolts being replaced in the fittings and the whole of the metal parts greased and wrapped in cloth, while the panels are placed in padded racks. Be sure that radiator is drained. Wrap magneto in layer of felt or heavy cloth.

CHECKING PARTS.

All the parts of the airplane should be checked over against a complete list before leaving the place of storage, and a receipt for the complete airplane, listing all these parts, should be secured from the officer in charge of the warehouse.

PROTECTION OUTDOORS.

If the airplane must be left in the field overnight, it should be placed in the lee of the barn, clump of trees, bushes, bank, or whatever is available for protection from the wind, and sunk as low as possible by digging trenches for the wheels. The airplane is placed with nose facing the wind, the tail lashed fast to a stake. Stakes are driven in front of and behind the wing skids and skids are tied to these stakes so as to allow but very little motion.

The controls are lashed fast so that the controlling surfaces will not be moved to and fro by the wind. The propeller, engine, and cockpits are covered closely with waterproof cloth. The propeller must not be left exposed to sunlight, as it will warp quickly. The magneto should be packed in waste if the weather is cold or wet and the radiator drained. Naturally, care must be taken to keep airplane clean and free from moisture.

DISASSEMBLY OF TAIL.

Get into the cockpit and loosen the turnbuckles on the rudder and elevator control wires. Go to the tail and disconnect first the elevator and then the rudder control wires, coiling them up. Remove the elevators, replacing the hinge pins in the fittings and securing them there with soft wire. Remove the rudder, replacing the hinge pins in the fittings and securing them there with soft wire.

Remove the vertical fin, replacing the nuts and bolts in fittings. Disconnect the stabilizer braces, replacing the nuts and bolts in the fittings. Remove the horizontal stabilizer, replacing the nuts and bolts in the fittings on the fuselage. Never stand elevators, rudder or ailerons on their trailing edges. If the fabric is worn through on the trailing edge of one of these controlling surfaces, the wind will strip it off when the airplane is in flight and leave the pilot helpless.

DISASSEMBLY OF LANDING GEAR.

Next remove safety wire from turnbuckles on landing gear and loosen the diagonal bracing wires. Slip a 4 by 6 timber under the fuselage, passing it under the end of the master strut, and with men on each side, lift the fuselage and rest beam across two horses. Take out cotter pins, remove nuts and bolts, and take off landing gear.

DISASSEMBLY OF CENTER SECTION.

Remove safety wire from turnbuckles on wires running to center section struts. Disconnect front brace wires, rear counter drift wires, and front cross wires, coiling them up. Take out strut bolts (lower)

and lift off center section panel, still attached to struts at their upper ends. Take out upper strut bolts and remove struts. Replace bolts and nuts in fittings, not in struts.

CARE OF PARTS IMPORTANT.

In disassembling an airplane, the parts must be handled with the greatest care. Remember that a strut will be permanently weakened if its outside fibers are only splintered, and on the battle front it is almost impossible to get new parts.

Especially make sure that all bolts, nuts and clevis pins are so secured in the fittings that they can not come loose and fall out. An airplane costing thousands of dollars may be kept on the ground for days because one specially designed bolt is lost.

CHAPTER XIII.

DUTIES.

CONSTRUCTION OF HANGARS.

The airplane is housed in a hangar and on flying fields at the front; this hangar is made either of wood or of metal, usually corrugated iron. At training schools, tent hangars of canvas are frequently used. In some cases, hangars are of steel and concrete, with concrete floors and easily operated rolling metal doors.

DUTIES OF THE CREW CHIEF.

The hangar may be built to accommodate from one to six or eight airplanes. The crew chief has charge of the hangar and is held responsible for the condition of the airplanes, hangar, and tools of the crew. The crew chief directs the work, sees that the airplane is cared for properly, aligned correctly, its motor kept in the best of condition and its hangar clean and in good shape at all times. One of his duties is to hand to the section chief each day a written report showing the actual number of flying hours or hours in the air, of each airplane, the number of hours each motor has run, the names of pilots and passengers, and particulars of all parts and supplies used and requisitioned by his crew. He must see that extra parts in good condition are promptly turned in to storerooms and not left around hangar.

DUTIES OF CREW.

The crew, usually consisting of eight men, is held responsible for the condition of the airplanes in its charge. The machines must be ready to fly at any time of day or night, and all regulations providing for the proper care of the airplanes and the hangar must be carefully observed by the crew.

In performing the day's work, two men are usually assigned to complete charge of the engine, connections, controls, instruments, and propeller. They are responsible for its satisfactory condition. To the other men of the crew are assigned particular parts of the